Molecular Weight of Potato Amylopectin as Determined by Light Scattering*

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MOLECULAR weights reported for amylopectin range from less than 200,000, as determined by end-group methods,[1] to 230 million by the light-scattering method.[2] We report here the results of light scattering measurements on potato amylopectin in water solutions and on acetylated amylopectin in several organic solvents.

Potato starch (potassium form[3]) was dispersed with vigorous stirring in water at 90°. The amylose was precipitated with pentanol. Amylopectin recovery was 90 percent. Scattering was measured[4,5] at angles with 135 to 22°. Reliable extrapolation to 0° could be made, proving the absence of large particles of dirt or microgel in the solutions. Concentrations ranged from 10^{-4} to 10^{-6} g/ml. Solutions were centrifuged at 40,000 rpm and then passed through ultrafine sintered glass filters. Three molecular weight determinations averaged 36 million±10 percent. Values at 546 and 436 mu for a series of solutions of varying concentration agreed to ±5 percent. The 90° scattering was unaffected by temperature in the range 25 to 75°. An amylopectin solution 0.5 *N* in sodium hydroxide was heated two hours at 90°. It showed less than 10 percent decrease in turbidity if oxygen was absent. An amylopectin solution was heated one hour at 120° in a sealed tube free from oxygen without appreciable change in turbidity. These results indicate that if the light-scattering particles are aggregates they are not broken up by temperature or alkali. In acetone solution the acetate of this amylopectin had a molecular weight (corrected for 40 percent acetyl content) of 38 million.

Nine fractions were obtained by adding ethanol to a water solution of this amylopectin containing 0.1 percent sodium chloride. The molecular weight of the fractions, which represented 93 percent of the amylopectin, ranged from 52 to 7 million. One-third had a molecular weight 48 to 52 million. The weight average for the nine fractions was 36 million. The particle diameter ranged from 4300A to 2200A.

Another potato starch (calcium form[3]) was dispersed by autoclaving at *p*H 6.0, and the amylose was removed by complexing with nitrobenzene and adsorbing on cotton. The molecular weight of the amylopectin was 14 million. The average particle diameter was 2900A. Again there was no effect of temperature on the 90° scattering. The difference in the molecular weight of the two amylopectin preparations is attributed to differences in the original starches or in the fractionation treatments.

Since completely acetylated potato amylopectin is apparently not entirely soluble in any single solvent, a partial acetate (40 percent acetyl) was prepared.[6] Turbidity of the acetate dissolved in acetone, chloroform, dioxane, nitromethane, and acetonitrile was measured. Because of less favorable dn/dc, the concentrations were higher than in water solution, and were, in general, 10^{-4} to 3×10^{-3} g/ml. In all these solvents the molecular weight, corrected for acetyl, was approximately 10 million. On deacetylation the molecular weight in water solution was also 10 million. There was no abnormality in the scattering at low concentrations to suggest dissociation of molecular aggregates, as has been suggested on the basis of osmotic pressure measurements.[7]

We believe our results mean that potato amylopectin has a weight average molecular weight of 10 million or more and that molecules of this magnitude probably exist in the starch granules and are not artifacts of preparation.

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